

Agronomic & economic results of improved cassava management (2017-18 & 2018-19)

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Australian Government

Australian Centre for International Agricultural Research





Outline

- Present the results of trials in 2017-19 and also 2018-19
 - Varieties
 - ► Fertiliser application
 - Intercropping
- Agronomic results
- Economic analysis
- Observations and future plans (2019-20)
- Implications of results will be presented tomorrow.



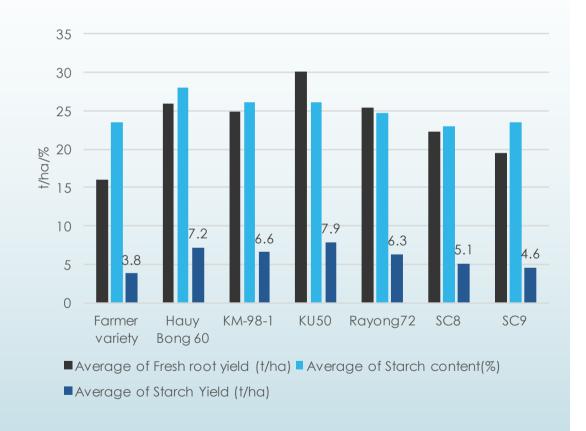
Variety trial 2017-18



Results impacted by disease

Problem with farmers harvesting trials early so only 1 site remained for harvest by team.

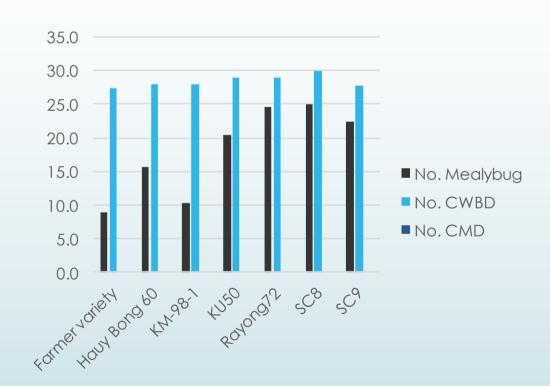
Variety	Fresh root yield
KU50	30.17 a
Hauy Bong 60	25.94 ab
Rayong72	25.41 ab
KM-98-1	24.91 abc
SC8	22.29 abc
SC9	19.44 bc
Farmer variety (likely KM419)	15.97 c



Average number of plants infected by pest and disease at time of harvest in Snuol

- High rate of CWBD across all varieties
- No CMD observed in 2017-18 season in Snuol trial location.





High CMD infection rates in Chet Borei

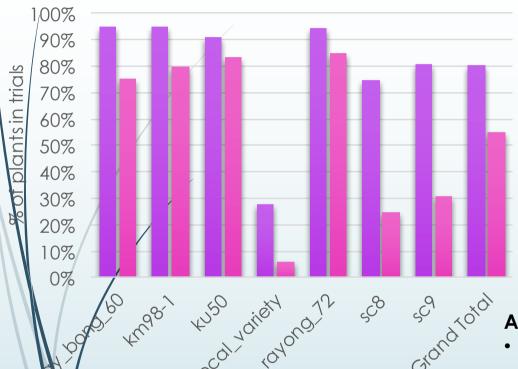
Location 2

LOCA	LOCATION 2																				
		v	rayo	ong_7	2		R	2	V	Loca	al vari	iety		R	3	V	huay	_bor	ng_60		
	P1	P2	Р3	P4	P5	P6		P1	P2	Р3	P4	P5	P6		P1	P2	Р3	P4	P5	P6	
R1	1	1	0	0	0	0	R1	М	1	1	0	1	1	R1	0	0	0	0	0	0	
R2	0	0	0	0	1	0	R2	1	1	1	1	1	0	R2	0	1	0	0	0	0	
R3	0	0	0	0	0	0	R3	1	1	1	1	1	1	R3	0	1	0	0	0	0	
R4	0	0	0	1	0	0	R4	0	1	1	1	1	1	R4	0	0	1	0	0	0	
R5	0	0	0	0	0	0	R5	1	1	0	1	1	1	R5	0	0	0	1	0	0	
		V	ku5	0					V	sc9						V	km9	8-1			
	P1	P2	Р3	P4	P5	P6		P1	P2	Р3	P4	P5	P6		P1	P2	Р3	P4	P5	Р6	
R1	0	1	0	0	0	0	R1	0	1	0	1	1	0	R1	0	0	0	0	0	0	
R2	0	0	1	0	0	0	R2	0	0	0	0	0	1	R2	0	0	0	0	0	0	
R3	М	0	0	1	0	1	R3	0	0	0	0	0	0	R3	0	0	0	0	0	0	
R4	0	0	0	1	0	0	R4	1	0	0	0	0	0	R4	0	0	0	0	0	0	
R5	0	0	0	0	0	0	R5	0	0	0	0	0	0	R5	0	0	0	0	0	0	
		V	km9						V	•	ng_7					V	sc8				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6	
R1	0	0	0	0	1	0	R1	0	0	0	0	0	0	R1	0	0	0	1	1	1	
R2	0	0	0	0	0	0	R2	0	0	0	0	0	0	R2	1	0	0	1	1	1	
R3	0	M	0	0	0	0	R3	0	0	0	0	0	0	R3	0	0	0	0	1	0	
R4 R5	0	0	0	0	0	0	R4 R5	0	0	0	0	0	0	R4 R5	0	1	1	1	0	0	
KO	U	-			0	0	KO	0	0	M	_	U	0	KO	1	_	_	_	-	0	
	P1	V P2	P3	al vari P4	P5	Р6		P1	V P2	ku50 P3	υ P4	P5	P6		P1	V P2	P3	l vari P4	ety P5	P6	
R1	1	0	1	1	1	0	R1	0	0	0	0	0	0	R1	1	1	1	1	1	1	
R2	1	1	1	1	1	1	R2	0	М	0	М	0	0	R2	1	1	1	1	1	0	
R3	0	1	1	1	1	1	R3	1	0	0	1	0	0	R3	1	1	1	1	1	1	
R4	0	1	1	1	1	1	R4	0	0	0	М	0	0	R4	1	1	1	1	1	М	
R5	1	1	1	1	0	1	R5	0	0	0	0	0	0	R5	1	1	1	1	1	1	
113	_	V	sc9	_	U	_	11.5		v	sc9				113	_	V		ng_7		_	
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	Р6	
R1	0	0	0	0	0	1	R1	M	0	1	0	0	1	R1	0	0	0	0	0	0	
R2	0	0	0	0	0	0	R2	0	1	М	0	1	0	R2	0	1	0	0	0	0	
R3	0	0	1	0	0	0	R3	1	1	1	0	М	0	R3	0	0	0	0	0	0	
R4	n	1,	٥	<u>_</u> n	n	n	R4	0	0	0	M	1	1	R4	n	n	n	n	n	n	
			M																		

- Farmers own variety is assumed to have been infected prior to establishment with surrounding fields also infected.
 - DNA finger printing showed variety was KM419 officially released in Vietnam in 2013
- Visual inspection of every plant occurred (May 2017)
- Samples collected and sent for PCR analysis
- Second round of visual inspection carried out (Nov 2017)
- No yield data due to farmer harvest

		V	ray	on	g_7	2		R	1				V	km	98-	1			R	2				٧	hua	ay_	boı	ng_	60	R	3	
	P1	P2	Р3	P4	P5	P6	P7	P8	P9	P1	0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10)	Р1	P2	Р3	P4	P5	P6	P7	P8	P9	P1
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	C
R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	C
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	1	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	(
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	(
		V	ku!	50				R	1				V	sc9)				R	2				٧	km	98-	1			R	3	
	P1	P2	Р3	P4	P5	P6	P7	P8	P9	P1	0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10)	Р1	P2	РЗ	P4	P5	P6	P7	P8	P9	P:
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	(
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	М	0	0	0	0	0	0	0	(
R3	0	0	0	0	0	0	0	0	1	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	(
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	1	0	R4	0	0	0	0	М	0	0	0	1	(
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	1	R5	0	0	0	0	0	0	0	0	0	
		٧	km	98-	1			R	1				٧	ray	on	g 7	2		R	2				٧	sc8	3				R	3	

Percentage of plants <u>without</u> visible symptoms



First Second

	Infection	rate (%)		om rate nfected)
	Location	Location	Location	Location
Variety	1	2	1	2
Huay Bong 60	6.7	0.0	100	0.0
KM98-1	6.7	5.6	100	100
KU50	0.0	0.0	0.0	0.0
Farmer's Local				
Variety	76.7	88.9	26.1	20.0
Rayong 72	43.3	61.1	84.6	81.8
SC8	16.7	27.8	80.0	60.0
SC9	16.7	66.7	40.0	58.3

Asymptomatic plants

- SC8/SC9 showed high levels symptoms by November 2017
- Rayong 72 was still not showing high levels of symptoms by the second inspection despite high levels indicated with PCR

^{*} DNA fingerprinting suggest SC8 and SC9 in the trial were the same variety.

Variety trial 2018-19



Rayong 72	Local	KM98-1	Rayong 60	Rayong 5	Huaybong60
KM98-1	Rayong 5	Rayong 60	Huaybong60	Local	Rayong 72
Local	Rayong 72	Huaybong60	Rayong 60	KM98-1	Rayong 5

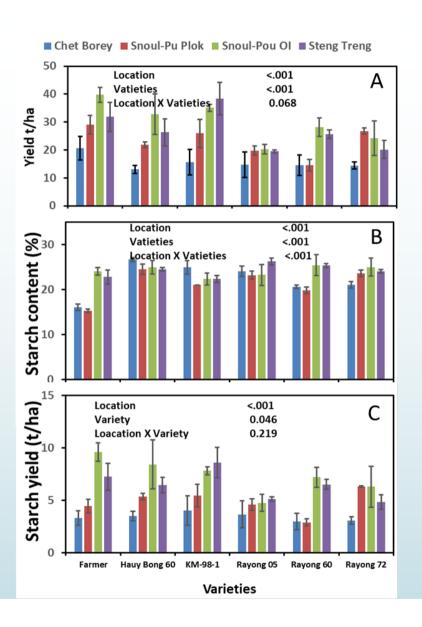
Rayong 72				Rayong 5	Huaybong60
28.77 KAA98.1				17.37 Local	20.83 Payona 72
37.93		A VALUE AND A	23.59	28.52	Rayong 72 24.71
Local 34.21	Rayong 72 2 7.1 7	Huaybong60	AND AND A STATE OF ST	Marian and Liver	Rayong 5
				V	
	28.77 KM98-1	28.77 24.51 KM98-1 Rayong 5	KM98-1 Rayong 5 Rayong 60 37.73 22.67 15.33	28.77 24.51 23.74 16.04 KM98-1 Rayong 5 Rayong 60 Huaybong60 37.93 22.67 15.53 23.59 Local Rayong 72 Huaybong60 Rayong 60	28.77 24.51 23.74 16.04 17.37 KM98-1 Rayong 5 Rayong 60 Huaybong60 Local 37.93 22.67 15.83 23.59 28.52 Local Rayong 72 Huaybong60 Rayong 60 KM98-1



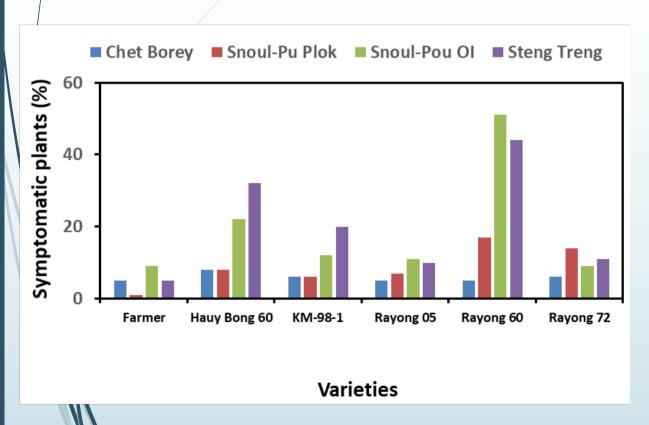


Agronomic results

- Among the varieties across all locations farmer's choice variety yielded highest, ranged from 20.6 to 39.7 t ha⁻¹ and Rayong 5 yielded lowest, ranged from 14.8 to 20.2 t ha⁻¹.
- While considering different locations, on an average for all varieties Snoul-(Pou OI) produced highest (i.e. 30 t ha-1) and Chet borey produced the lowest (15 t ha-1)
- Starch content was significantly different at variety x location interaction (p <0.001)).
- On an average across all locations starch content of Hauy Bong60 was highest (i.e. 25.2 %) and Farmers' choice variety had the lowest (i.e. 19.6%).
- However, starch yield was not significantly different at variety x location interaction (Fig 1C).



Observed CMD prior to harvest



- Number of CMD symptomatic plants differed among 6 varieties across all locations
- Percentage of CMD symptomatic plants was highest (i.e. 29.3%) for Rayong 60 and lowest for Farmer's choice variety (i.e. 5%).
- Among 4 locations percentage of CMD symptomatic plants were on average highest in trails Snoul-Pou Ol and Steng Treng for all the varieties, 20 and 19.3%, respectively.

Conclusion on varieties

- Ranking of varieties following the criteria of the fresh root yield and starch content came out very different-
 - ► FRY Farmer's choice variety came out at the top; however,
 - Starch % the same variety came out at the bottom.
 - Although when ranking was calculated following starch yield farmer's choice variety came out as second precede by variety KM98-1.
 - Ranking on the disease susceptibility (i.e. % of symptomatic plants), Farmer's choice variety ranked the top and Rayong 60 bottom.
- The current pricing system does not provide incentive for high starch content.
- It is assumed that stems in the trial were CMD free at time of planting. However other results have shown high levels of asymptomatic infection which would produce a different result in the following year.

Fertiliser trials 2017-18





Fertiliser use in NE Cambodia remained low in project villages.

	Krati	e	Stung Treng	Total
Name of district	Chit Borei	Snuol	Siem Bok	
Do you apply organic fertiliser to your cassava?	2.97%	1.00%	0.00%	1.29%
Do you apply inorganic fertiliser to your cassava?	7.92%	5.00%	4.55%	5.79%
Do you understand what the NPK values mean on the fertiliser you apply?	1.98%	2.00%	0.00%	1.29%
Have you ever seen a fertiliser trial on cassava?	22.77%	34.00%	17.27%	24.44%
Are you interested in visiting a fertiliser demonstration trial to see the result on production and returns?	87.13%	91.00%	70.00%	82.32%
Are you interested in conducting a trial on your own land?	75.25%	62.00%	58.18%	64.95%

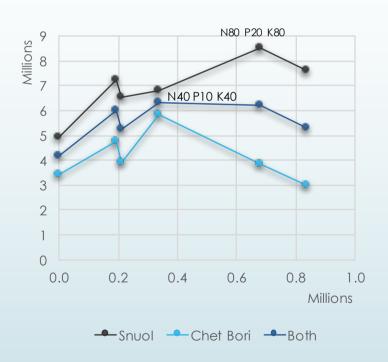
Agronomic results of fertiliser trial

- Root yield was significantly different (p<0.001) between two locations.
- However, there was no difference between the treatments in each location due to large variability caused by biotic (root rot, CMD and CWBD) stresses.
- The average fresh root yield was 1.4- to 2.2-fold higher in the Snuol District compared to Chit Borei District.
- The highest yield (26.3 ± 6.7 t ha-1, Snoul) was achieved with highest fertilizer rate.
- In Chit Borei District highest yield was 17.6 ± 1.0 t ha-1 with moderate fertilizer application.
- In general fertilizer application yielded higher fresh root compared to Farmers' practice and without any fertilizer application.

Treatment	Chit Borei (t/ha)	Snoul (t/ha)
Farmer practice*	11.8	19.3
N40 P10 K0	14.2	21.2
N40 P10 K40	17.6	20.3
N40 P10 K40 + CM 5T/ha	11	24.2
N80 P20 K80	12.9	26.3
No fertilizer	9.7	7 14
Fertilizer	P= 0.172, I	S.D.= 6.31
Location	P<.001, L	.S.D.=3.64
Fertilizer x Location	P=0.403, L	S.D.=8.92
*(20:20:15=100kg/ha)		

Net benefits and marginal rate of return analysis

Treatment	Cost of treatment	Snuol	Chit Borei	Both
No fertilizer		4,911,667	3,409,259	4,160,463
N40 P10 K0	191,987	7,224,124	4,779,309	6,001,717
Farmer practice (20:20:15=100kg/ha)	210,000	6,545,000	3,925,185	5,235,093
N40 P10 K40	338,661	6,774,117	5,818,746	6,296,43 1
N80 P20 K80	677,322	8,539,344	3,853,233	6,196,289
N40 P10 K40 +CM5T/ha	838,661	7,619,672	2,995,135	5,307,404

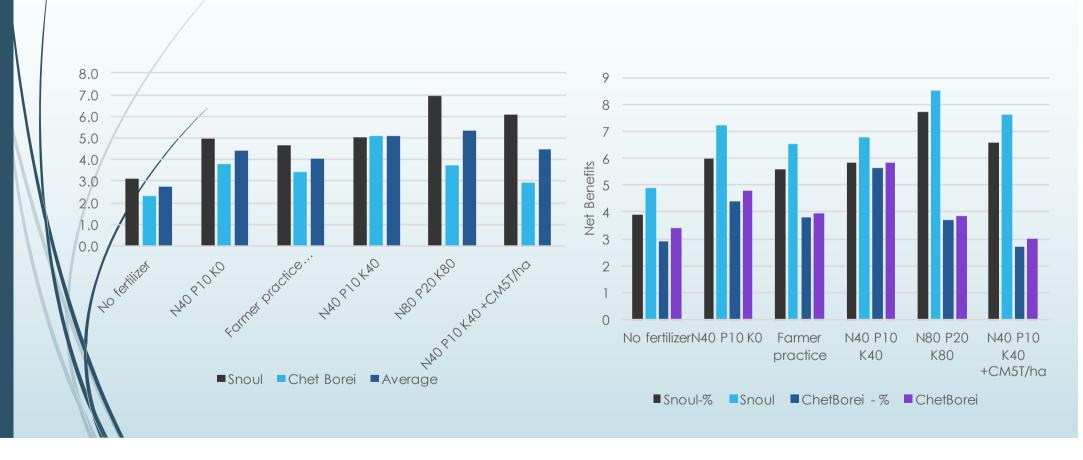


Year 1 conclusion

- Significant uncertainty surrounding fertiliser application when biotic and abiotic stresses are present.
- Given that there was no significant difference between fertiliser rates, the least expensive rate would be recommended, however given it is only one year of result no recommendation can be safely made.
- If average responses are considered, a \$50 USD investment in fertiliser produced a marginal net benefit (MDB) of over \$570 for N40 P2O510 K2O 0. At all probable root prices the MRR would be above 200%.
- An additional \$120 USD investment (\$170 USD total) required for the high balanced rate produced a MNB of \$329 USD equivalent to a MRR of 270%. This would remain above 200% for prices above 280 Riel/kg (analysis done at 350 Riel).
- In Chet Bori District, once again the cheapest rate (N40 P2O510 K2O 0) produced a high MRR (714%), while the additional of potassium (N40 P2O510 K2O 40) also produced a high MRR (709%).

Impact on starch content & starch yield

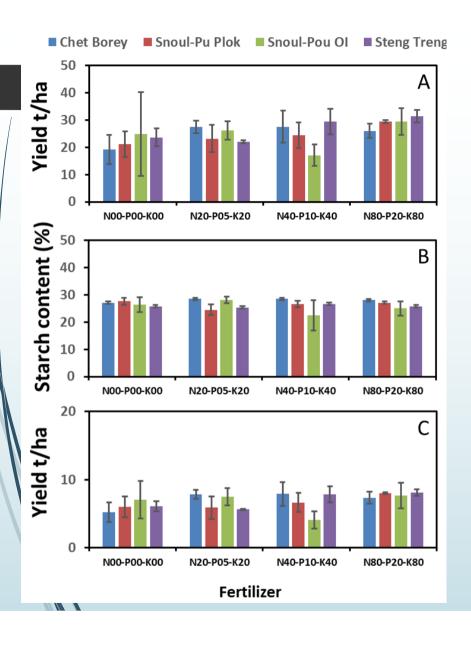
- Application of fertilizer increased starch content in all treatments ranged
- This becomes more important when prices are paid on starch content



Fertiliser trial 2018-19



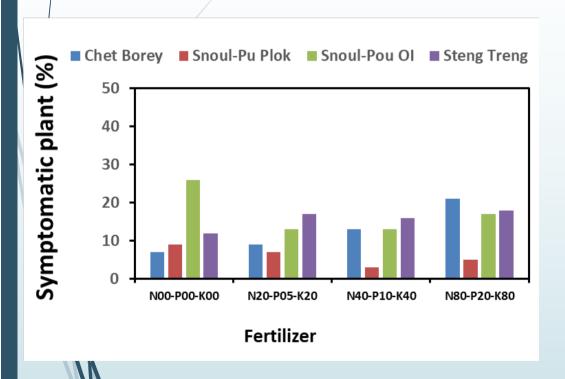




Fertiliser agronomic results

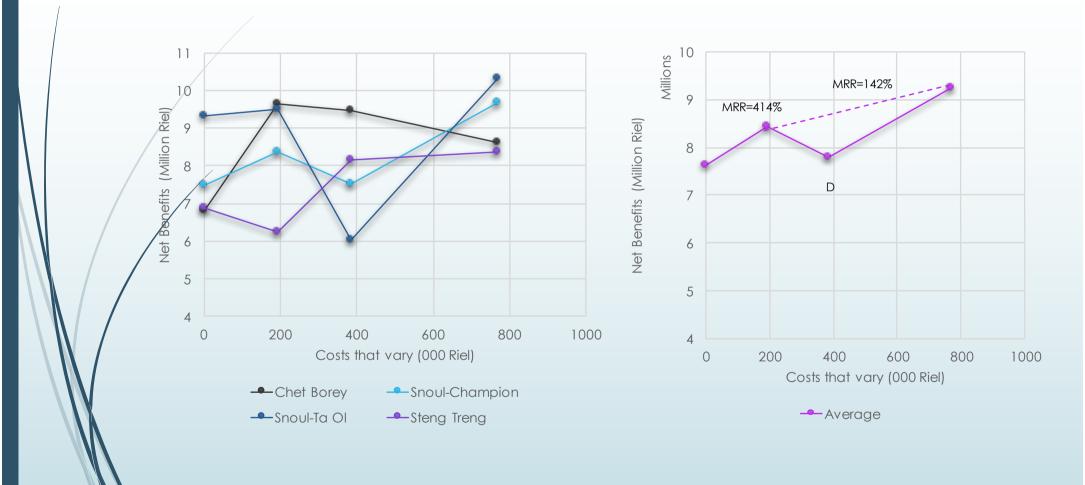
- Fresh root yield was not significantly affected by the location x treatment interaction because fertilisation treatment responded similarly across treatment and location (Fig 3A).
- ► However, highest fertilizer treatment (i.e. 80N-P20-K80) produced highest (29 t ha⁻¹) and no fertilizer application produced the lowest (22 t ha⁻¹) fresh root yield on average of all locations which is an increase of yield by 1.3 fold.
- Yield increase by 1.13-fold was observed at minimum fertilizer (20N-P05-K20) application compared to no fertilization on an average of all location.
- Highest yield increase was 1.45-fold at Chet Borey when applied minimum fertilizer (20N-P05-K20) compared to no fertilization.
- Starch content and Starch yield was not significantly affected by the location x treatment interaction (Fig 3B and C).

Did fertiliser effect the appearance of CMD symptoms?



- Number of CMD symptomatic plants did not differed when compared across all locations and all fertilizer treatments (ranged ~11 to 15 %)
- There was no clear trend in percentage of symptomatic plants considering different fertilizer treatment.

Economic results



Impact of CWBD



Impact on farmer incomes of price and yield

Snoul District, Kratie

Chet Borei District, Kratie

/			
	F	Root price (Rie	/kg)
Yield (t/ha)	80	240	340
10	-1,265,000	335,000	1,335,000
15	-865,000	1,535,000	3,035,000
20	-465,000	2,735,000	4,735,000

		Root price (Riel,	/kg)
Yield (t/ha)	60	230	360
5	-2,230,000	-1,380,000	-730,000
10	-1,930,000	-230,000	1,070,000
20	-1,330,000	2,070,000	4,670,000
30	-730,000	4,370,000	8,270,000







	Snoul (Ch	nampion)	Chet	Borei
	\A/:Lla a	VACIAL FOREST	Without	NAVILLE E - LITTE - L
	Without fertiliser			With fertiliser
Material costs (A)	1,070,000	1,840,480	1,830,000	2,023,320
Labour costs (B)	755,000	795,000	700,000	740,000
Total costs (A+B = C)	1,825,000	2,635,480	2,530,000	2,763,320
Revenue (D)	7,484,681	10,463,934	6,810,882	9,821,436
Net returns (D-C)	5,659,681	7,828,454	4,280,882	7,058,116
Gross Margin (USD)	1,415	1,957	1,070	1,765
Net returns to household				
resource (D-A = E)	6,414,681	8,623,454	4,980,882	7,798,116
Labour days (F)	32	34	23	25
Net returns per labour day (E/F)	200,459	253,631	216,560	311,925
	Low price s	cenario		
Revenue	2,138,480	2,989,696	1,945,966	2,806,124
Net returns	313,480	354,216	-584,034	42,804
Gross Margin (USD)	78	89	-146	11
Net returns to household				
resource	1,068,480	1,149,216	115,966	782,804
Labour days	32	34	23	25
Net returns per labour day	33,390	33,800	5,042	31,312
Net returns per labour day (USD)	8.35	8.45	1.26	7.83

Transition to tree crops

 Farmers in some locations transitioning to tree based systems and show limited interest in investing in their cassava



Farmer response

- Variety
 - Yield
 - Good big stakes
- → Fertiliser
 - ≠ Yield
 - Affordable cost
 - High return







Plan for 2019-2020

- ► KU50 variety vs farmer's choice variety
- Zero fertilizer vs lowest fertilizer rate
- 5 locations in Kratie

Thanks you

